
An approach to health and safety in E.U. forestry operations – Hazards and preventive measures

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Abstract

Forestry in general and logging in particular continue to be among the three most hazardous sectors in European countries. The aim of this article is to characterize health and safety problems and solutions in E.U. forestry operations, and particularly in Portuguese operations. Forest types, production, employment and ownership are used to characterize the forest sector. Forestry accidents and health problems data are mentioned. Typical hazards associated to the nature of logging operations are systematized. Preventive measures, focused on a wide spectrum of measures, making safety considerations an integral feature of all operational activities from planning to organization to execution and supervision of work are emphasized in this article.

Keywords: Working conditions, forestry economics

JEL classification: J08; J28; L73

1. An introduction to European forestry

1.1 Forest types in Europe

A forest is an area with a high density of trees (or, historically, an area set aside for hunting). Natural forest originates from the original forest cover, i.e. a forest reproduced naturally [34].

We may assume three main types of forest in E.U.: (1) Boreal and hemiboreal forests, (2) Forests of central Europe and (3) Broadleaved evergreen forest and Coniferous forests of the Mediterranean. The first type of forests are dominant in North Europe, in countries like Estonia, Finland, Germany, Latvia, Lithuania, Norway, Poland, Russia and Sweden (firs, spruces and pines). The second type of forest are dominant in Central Europe and the third type of forest is dominant in places like Azores, Canaries, Cyprus, Greece, Portugal and Spain [4]. Eucalyptus,

cork oak, stone pine and maritime pine, chestnut and holm oak are dominant in the mediterranean forests [6] (Table 1).

Table 1
Distribution of forest specimens in Portugal

Specimens	Forest Area (1.000 ha)	Forest Area (%)
Maritime Pine (<i>Pinus pinaster</i>)	976	29.1
Stone Pine - Umbrella Pine (<i>Pinus pinea</i>)	78	2.3
Cork Oak (<i>Quercus suber</i>)	713	21.3
Eucalyptus (<i>Eucalyptus</i> spp.)	672	20.1
Holm Oak (<i>Quercus rotundifolia</i>)	462	13.8
Oak (<i>Quercus</i> spp.)	131	3.9
Sweet Chestnut (<i>Castanea sativa</i>)	41	1.2

1.2 The land use in European Countries

The European Union (EU-25) has a total area of forests and other wooded land of 160 million hectares, covering 42% of its land area. The wooded area (forest and other wooded land) expressed as a percentage of land area, for some E.U. Countries (1998 data) ranges from 75% in Finland to 9% in Ireland. Portugal has 38% wooded area, similar to Norway (39%) and Italy (37%) [10].

1.3 The round wood production in E.U.

At world level (according to FAO data) EU-25 accounts for 11% of worldwide round wood production, thus ranking it second behind the United States (14%) [38].

Round wood production in EU-25 (376 mio m³ in 2004) has been increasing for the last 15 years, with the increase concerning primarily industrial round wood. The main producers, accounting for 67% of EU-25 production, are in descending order: Sweden, Finland, Germany, France and Poland. The trend in these five countries has been upward since 1992, with the rise most marked in Poland and least marked in France.

The Mediterranean countries (FR, ES, PT, IT, CY, EL and MT) produce practically equal amounts of coniferous and non-coniferous wood, accounting for about 13% of EU coniferous wood production and approximately 35% of non-coniferous production.

1.4 The sawn wood, wood-based panels and paper and paperboard production in E.U.

The EU is the world number one producer of sawn wood, wood-based panels and paper and paperboard. The enlargement of the Union in May 2004 increased the Community's forest and other wooded land area by 20%, from 136 up to 160 million hectares. The volume of growing stock rose by one-third, to 17.9 billion cubic meters. This represents a remarkable expansion of the EU's forestry sector, and has given the EU, among other things, a greater importance as a producer and trader of wood and wood-based products [26].

1.5 Other forestry products in E.U.

Forests provide a variety of non-wood forest products such as cork, Christmas trees, resins, pine nuts, medicinal plants, mushrooms and berries.

Cork is one of the most important non-wood forest products in the EU, with approximately 1.7 million ha of cork oak forests accounting for 80% of its production worldwide.

Pine nuts (seeds of *Pinus gerardiana*, *P. pinea*, *P. korainsis* and *P. cambra*) are an important forest product with a growing and high-value market.

Black mushroom or morels, belonging to genus *Morchella*, are another product of considerable economic and commercial significance.

Like morels, truffles are also highly favoured by gourmets in various European countries and USA. France and Italy are the main producers.

The chestnut assumes more importance in Italy and those countries bordering on the Italian frontier and on the Mediterranean basin than in other European countries.

The holm oak is native to the Mediterranean region. The wood is used and charcoal manufacture.

Another important branch of forest industry is the production of Christmas trees. About 7 million Christmas trees are felled each year in Denmark, some 80% of them for export. Denmark is Europe's leading exporter of Christmas trees [23][24].

1.6 The forestry production in Portugal

Paper and paperboard production, round wood production, sawn wood and cork production are the most relevant forest products in Portugal. The

Portuguese production was respectively 1.7% [13], 3.1% [14] and 1.1% [12] of E.U. production (2004 data).

Cork is harvested exclusively from the Cork Oak, *Quercus suber L.*, found predominantly in the Mediterranean region. Portugal is the world's major producer of cork and produces about 52% of the world's cork. The bark is manually harvested from a cork tree with a special axe during the period May-August.

Cork production has shown significant expansion in recent years - reflecting the impact of approximately 120,000 hectares of highly productive, new cork forests in Spain and Portugal [8] (Table 2).

Table 2
World cork production

Country	Forest Area (ha)	World's Forest Area (%)	Production Tons (1.000)	World's Production (%)
Portugal	725,000	33%	175	52%
Spain	510,000	23%	110	32%
Italy	225,000	10%	20	6%
France	22,000	1%	5	1%
Morocco	198,000	9%	15	4%
Algeria	460,000	21%	6	2%
Tunisia	60,000	3%	9	3%
Total	2,200,000	100%	340	100%

Forestry represents 10 per cent of Portugal's exports (in 2005 exports were equivalent to 2.5 billion euros in value). In the case of the cork industry, the exports reached a value of 838 million euros – representing 33.4 per cent of the total forestry exports.

Spain and Portugal are the major producers and exporters of pignolia nuts (*P. pinea*).

1.7 The employment in the forest sector

The total forest industry in the EU (including Russia and Turkey) employs about 4 million people [5][33], split up into 1.4 million total employment (FTE) in the forestry, 1.5 million in the wood industry and 1.1 million in the pulp and paper industry [35][3]. Poland has 64,400 FTE and Germany 61,520 FTE. The employment in the forest sector decreases in many European countries due to rapid increases in mechanisation. However in Spain (+28%), Ukraine, (+26%) and Latvia (+6%) the employment in the forest sector increases [27].

In Portugal, the employment in the Forestry sector was 11.104 FTE (2005) with a tendency to decrease to 10,839 in 2010; the employment in the wood industry was 22,142 FTE (2005) with a tendency to decrease to 21,529 by 2010 [3].

1.8 Forest ownership

Forest ownership in Europe varies considerably from country to country. In many countries there is a high proportion of private forest (including private ownership, private forests owned by individuals, and forest owned by other private institutions): Denmark (68%), Spain (81%), France (74%), Italy (66%), Austria (84%), Portugal (84%), Slovenia (70%), Finland (71%) and Norway (85%) [11].

In other countries the proportion of public ownership (including public ownership, state ownership and owned by other public institutions) is determinant: Czech Republic (84%), Estonia (91%), Greece (78%), Ireland (66%), Lithuania (83%), Poland (82%), Bulgaria (100%), Romania (94%), Turkey (100%), Switzerland (66%), and Russian Federation (100%) [11].

In countries like Sweden (20%), Portugal (5%) and Finland (4%) the forest is also owned by forest industries [11].

In Europe as a whole, 68% the forest is privately owned and 27% public owned; 5% is owned by forest companies [11].

2. Introduction to forestry operations

Logging is the process in which trees are cut down usually as part of a timber harvest. Two groups of operations may be identified in forest work: manual and mechanized operations. Logging is a very hazardous industry, particularly the activity of manual felling.

While logging injuries have been declining in recent years due to mechanization, increased safety awareness, and accident prevention, the rate remains high compared to other industries. For operations employing manual chainsaw felling and delimbing, the most frequent and serious accidents involve workers on the ground being struck by a falling tree, limb, top, or rolling log while operating a chainsaw. For fully mechanized operations (felling and delimbing are performed by a worker in the protected cab of a machine) a significant number of injuries occur during equipment repair and maintenance in the field [28].

Table 3
Typical manual operations in forestry work

Operation	Charaterization
Felling	To "fell a tree" means more than just cutting it down. Felling means to cut the tree in such a way that it falls in the desired direction and results in the least damage to the tree.
Limbing	Limbing is the process of cutting branches from the stem of felled or standing trees. Options for cutting off the branches include chain saws, harvesters, de-limbers and other options.
Bucking	Bucking is sawing felled trees into sections called logs. The length of the logs is dependent on the species of the tree and type of final product.
Yarding	Yarding is the movement of felled trees to the landing area can present hazards to employees from both skidding or cable operations.
Log Loading and Transporting	Loading and unloading logs can present employee hazards from the inadvertent release of logs as well as the movement of the loader itself.

The use of machines and vehicles during logging operations can present hazards to the operators and other employees in or on the machines or vehicles or in the vicinity of the operations (Table 4).

Table 4
Typical mechanized operations in forestry work

Operation	Charaterization
Feller Buncher	A Feller Buncher is a mobile machine, either rubber tired or tracked, with a power plant, operator enclosure, and an articulating extensible arm onto which a felling head is attached. The grappling devices wrap around the tree and the saw severs the tree from the stump. The machine then takes the severed vertical tree and lowers it into a horizontal position onto a pile or bunch of trees on the ground.
Feller Forwarder	A Feller Forwarder is a feller buncher with a bunk to the rear of the operator into which the felled trees are lowered and carried to the next tree to be felled. The process is repeated until the bunk is full. The machine then moves or forwards the trees to the landing and unloads them.
Grapple Skidder	A Grapple Skidder is a rubber tired four-wheel-drive machine consisting of a power plant, operator enclosure, forward dozer blade and a maneuverable grappling device at the back of the machine. These machines are generally used where feller buncher machines are working. The operator opens and lowers the grapple onto the trunks of the trees and then closes the grapple and raises the tree trunks slightly off the ground. The machine then moves the trees through the woods to the landing and drops them off.

Table 4 continuation

Forwarder	A Forwarder is a tracked or rubber tired machine consisting of a power plant, operator enclosure, dozer blade, articulating grapple, and a bunk to the rear. This machine usually follows the processor and picks up the cut-to-length logs, places them in the bunk and then takes the logs out of the woods and piles them at the landing. It then moves back into the woods to repeat the process.
Processor/ Harvester	A Processor is a mobile machine consisting of a power plant, operator enclosure and a maneuverable articulating arm onto which a processing head is attached. This machine often follows a feller buncher and picks up one tree at a time from the tree pile or bunch. Rollers pull the tree through a clamp, which removes all branches; then a saw in the processing head cuts off the top of the tree.

3. Accidents in the European forestry industry

3.1 Comparison among E.U. countries

The worst working conditions are usually found in forestry. Forestry in general and logging in particular continue to be among the three most hazardous sectors even in European countries.

It is difficult to make comparisons between countries since definitions and quality of accident reporting differ widely from one country to another [3]. The safety and health situation is most problematic among the self-employed, farmers and contractors [32]. In the UK the number of fatal accidents among directly employed forest workers fell between 1990 and 1997, while the number of fatalities among contractors increased [22][3].

3.2 Accidents incidence rates in U.K.

Accident statistics for Forestry Commission employees show an annual rate of around 10 reported accidents per thousand employees, on average for the 4 years to 2004/05. Detailed industry statistics on accidents reported to the Health & Safety Executive are available for the seven years 1996-97 to 2002-03 [18]. The annual averages for employees in forestry are shown below; these exclude accidents to the self-employed [15] (Table 5).

Table 5
Forestry accidents in U.K.

	Major accidents	Total reported accidents
Number of reported accidents	52	162
Rate / 1000 employees	4.6	14.6

For comparison, reported accident rates per 1000 employees for employees in all sectors were about 1/1000 for major accidents and about 7/1000 for all reported accidents. For employees in manufacturing, accident rates were about 2/1000 for major accidents and about 12/1000 for all reported accidents [15].

Compared with other industries in UK the forestry and arboriculture sector shows the highest rate of fatal and major injuries between 1990-99. Major injuries include fracture other than to fingers, thumbs or toes, amputation, dislocation of shoulder, hip, knee or spine and any other injury requiring admittance to hospital for more than 24 hours [19].

3.3 Accidents incidence rates in Spain

Although the figures provided above give an idea of the magnitude of the problem, official data on the incidence of occupational accidents and diseases are imprecise and notoriously underestimated in forestry.

In Spain, 11,535 accidents were reported in the period 1999-02, including 31 fatal accidents. During the same period, the percentage of serious accidents was 1.58-1.99% of the total number of accidents (Galícia and Navarra communities). The incidence rate in Galícia (2004) was 206 accidents / 1,000 employees. This number in Navarra was 286.3 (2003) and 293.0 (2004). Accidents are extremelly high in these Spain communities [7].

3.4 Accidents incidence rates in France

The evolution, from 1993 to 1997, of the incident rate for 4 activities (sylviculture, logging, sawmill, agriculture) shows that (1) the rate for logging operations is very important in comparison with the other 3 activities and especially with the agricultural works, (2) 63% of the accidents in logging activities occur during the felling (25%), conversion (23%), delimbing (11%) operations (3) the share of serious accidents and their occurrence are higher in felling activity and conversion [25].

From 1978 to 1999, the accidents incidence rate (accidents with sick leave * 10^6 / work hours) was 120-160. The evolution of the gravity of the work accidents (non-working days with allocation/ working hours) in the same period was ~9,000 in 1999. Serious accidents rate (a rent is given after a serious accident) was ~15-20% durind the same period [25].

In France happen more then 3,000 accidents in the forestry every year, the forestry sector is also in France one of the high-risk sector [29].

3.5 Accidents incidence rates in other E.U. countries

Results by the statutory accident insurance institutions for agriculture and forestry in Germany, show that fatal accidents based on 1 000 injuries are three times more likely in the forestry sector than in the construction sector and two times more likely than in the agriculture sector. The main reasons for accidents in Germany are falling trees and branches (40%), slips and trips (30%) and tools and machineries (17%).

In Austria there had been altogether 1.830 accidents in the forestry industry in 2002 and thereof 23 fatal accidents.

In Latvia the accident rate has increased: five fatal accidents and five serious accidents every year.

In Sweden there had been 27 fatalities in the years 1990 to 2001 among the self-employed forest workers. The main reasons for fatal accidents in Sweden are falling trees (55%), accidents with vehicles (17%) and accidents with machineries (14%).

4. Health problems in the European forestry industry

A lack of statistical data is observed concerning health aspects of forestry work in European countries. However, forestry workers are also beset by serious health problems.

A positive trend is the decline of vibration-induced disorders as a result of improvement in chainsaws [2]. Vibration induced white fingers (VIWF) was practically eliminated in Sweden as a health hazard by technical improvements and anti-vibration systems.

Noise level during chainsaw work has been reported as an important health risk in forestry works [2]. Noise levels have been reduced in Sweden from 110 to 95 dB(A). The risk of hearing impairment remains, however and hearing protection continues to be a crucial issue [2].

Chainsaw work is still heavy even with modern chainsaws with reduced weight (5 to 8 kg). The work involves handling and lifting timber, in which unfavourable working positions often cannot be avoided. Musculoskeletal complaints, notably lower back problems, are frequent.

In Sweden, some 50% of logging-machine operators have symptoms of repetitive stress injuries (RSI). The specialized logging-machine operator is sitting many hours per day inside the cabin, working mostly with his arms and hands, with a high degree of concentration on the job, which has led to new health risks. A Norwegian survey concluded that 88% of machine operators suffered from musculoskeletal disorders, especially

neck and shoulder complaints [30]. Many loggers have been observed working long hours in addition to commuting long distances.

5. Hazards in forest work

5.1 Electrical hazard

Electricity supply lines (overhead powerlines) represent a particular danger for people working in forestry and arboriculture. Forestry workers may receive severe burns, for example, when trying to remove trees felled onto overhead power lines.

5.2 The work environment hazards

Much forested land is located in upland areas. Often the terrain is boggy and strewn with rocks. Working in a hot climate puts pressure on the forest worker engaged in heavy work (the heart rate increases to keep the body temperature down). In a cold climate the risk of musculoskeletal injuries (MSI) and accidents increases. Rainy conditions, especially in combination with cold, mean higher risk of accidents, since tools are more difficult to grasp. In addition, weather changes from dry to wet or vice versa and strong winds have an impact on the work and the worker.

5.3 Mechanical hazards

Mechanical hazards are very frequent in forestry operations (Table 6).

Table 6
Summary of mechanical hazards in forestry operations

Mechanical Hazard	Characterisation
Mechanical harvesting	The use of machines and vehicles during logging operations can present hazards to the operators and other employees in or on the machines or vehicles or in the vicinity of the operations.
Falling trees and branches	Falling timber is a major cause of serious and fatal injuries in forestry.
Yarding	Hazards to employees come from the movement of logs and inadvertent release of the cables from the logs.
Chainsaws	The chain saw is one of the most efficient, productive, and dangerous portable power tools used in any industry. Chainsaws have the potential to cause horrific injuries.
Falls from trees	Working in trees requires specialist training and a disciplined approach to the work.

Table 6 continuation	
Processing and landscaping work	Processing timber products (both wanted and unwanted) often involves using machines with high-speed cutters that saw, chop and grind wood. Although not often fatal, injuries on processing equipment often involve the amputation of fingers and toes.
Log Loading and Transporting	Loading and unloading logs can present employee hazards from the inadvertent release of logs as well as the movement of the loader itself.
Limbing	When the tree is lying on the ground, branches may be storing enormous potential energy through mechanical strain. When a branch is cut, often with a chain saw, this energy can be released suddenly and the branch can jump dangerously. In addition, a branch may be supporting the tree, and the tree can fall or roll when the branch is cut.

5.4 Biological hazards

People in forestry works are exposed to health hazards from animals, plants, bacteria, and viruses (Table 7).

Table 7
Summary of biological hazards in forestry operations

Biological Hazard	Charaterization
Plants and wood	Most common are allergic reactions to plants and wood products (wood, bark components, sawdust), especially pollen. Injuries can result from processing (e.g., from thorns, spines, bark) and from secondary infections.
Animals	Poisonous snakes, spiders, bees, wasps, hornets, ants and scorpions are examples of poisonous dangerous animals in forest works.
Infections and diseases transmitted by animals	The most common carriers (vectors) in Europe are ticks. They carry bacteria that may cause Lyme disease and viruses that may cause encephalitis. Small rodents transmit direct or indirect Leptospirosis. In most cases indirect transmission happens via contact with <i>Leptospira</i> contaminated water or soil because forestry workers often can't access clean water to wash before eating.

5.5 Chemical agents hazards

Exhaust products from engine power portable machines, explosives handling and pesticides and herbicides are the most important chemical agents in forestry operations (Table 8)

Table 8
Summary of chemical agents hazards in forestry operations

Chemical Hazard	Charaterization
Exhaust gases	Some of the exhaust gases are formed during combustion, and the main toxic product among them are carbon monoxide, aldehydes, mainly formaldehyde, and nitrogen oxides [31].
Oil aerosols	Two-stroke engines power the portable machines used in forestry, where lubricating oil is mixed with gasoline. Lubrication oils as well as chain oils are mineral oils, synthetic oils or vegetable oils. Oil aerosols may create health hazards such as irritation of the upper respiratory tract and eyes, as well as skin problems.
Gasoline aerosols	The main component of chain-saw exhaust gases is unburned gasoline. Usually about 30% of the gasoline consumed by a chain saw engine is emitted unburned.
Explosives	Loggers for clearing obstacles may use explosives. They present an extreme hazard if improperly stored, transported, or used.
Pesticides	Pesticides are used in forests and forest nurseries to control fungi, insects and rodents.
Herbicides	In forests herbicides are used to control hardwood brush, weeds and grass in young softwood sapling stands. Phenoxy herbicides, glyphosate or triazines are used for this purpose. For occasional needs, insecticides, mainly organophosphorus compounds, organochlorine compounds or synthetic pyredroids may also be used. In forest nurseries dithiocarbamates are used regularly to protect softwood seedlings against fungus of pines.

Loggers often complain about irritation of the upper respiratory tract and eyes, headache, nausea and fatigue, which can be at least partly explained by these exposure levels. Substituting mineral motor and hydraulic mineral oils by biological oils and the use of catalytic converters reduces the exposure risks to exhaust gases.

The symptoms caused by excessive exposure to pesticides vary greatly depending on the compound used for application, but most often occupational exposure to pesticides will cause skin disorders [31].

5.6 Noise

Noise is a problem when working for example, with a chain saw or a brush saw. The noise level of most chain saws used in regular forest work exceeds 100 dB(A). The operator is exposed to this noise level for 2 to 5 hours daily. Still, many chain-saw operators suffer loss of hearing. In Sweden around 30% of chain saw operators had a serious hearing impairment [31].

Professional logging-machine operators are exposed to noise levels from above 95 dB(A) to 80 to 85 dB(A) [2]. Professional chainsaw operators are exposed to noise levels between 110 to 95 dB(A). The risk of hearing impairment exists and hearing protection is a crucial issue [2].

5.7 Vibrations

Professional logging-machine operators may be exposed to whole-body vibrations, particularly when operating equipment with defective cab design in terms of seat and controls.

Hand-arm vibration induced by chainsaw (vibration induced white finger) has been reduced as a health hazard by technical improvements and anti-vibration systems; however long working hours with this equipment may still represent a risk factor to vibration induced white finger.

5.8 Postures, loads and movement (ergonomic problems)

Chainsaw work is still heavy even with modern chainsaws with reduced weight (5 to 8 kg). The work involves handling and lifting timber, in which unfavourable working positions often cannot be avoided. Musculo-skeletal complaints, notably lower back problems, are frequent.

Logging-machine operators are sitting many hours per day inside the cabin, working mostly with his arms and hands, with a high degree of concentration on the job, which has led to new health risks. Repetitive Stress Injuries, RSI, well known from modern industry work, are characterized by complaints and injuries to the neck, shoulder, arms, low back and cervical spine.

People who handle timber and work with chainsaws are more prone to suffer from back pain (back strain). Examples of work situations that may pose a risk to low back injuries includes levering over a tree, moving pieces of timber, using chainsaws and handling timber.

5.9 Psycho-social hazards in forestry work

Forest work is usually done by small groups of workers often widely scattered on frequently changing worksites. This renders supervision and control difficult and demands a great deal of self-sufficiency and independence from workers to adequately organize their jobs and to take care of themselves. Commuting over long distances from home to work is common, often under poor road conditions. This extends working time and can be uncomfortable and dangerous particularly if the means of transport is in bad condition.

Poorly planned and organized forest operations and badly equipped workers can have a very negative impact on working conditions. Delays, down-time of machines, blunt tools, unbalanced distribution of work within a team and further inconveniences resulting from bad planning and supervision can make the work unnecessarily difficult, hazardous and frustrating.

6. High-risk operations

Tree climbing, clearance of windblow, and forest fires and fire-fighting are among the most dangerous forestry operations.

A risk assessment should be carried out before starting work involving tree climbing.. The appropriate equipment and number of operators should be decided upon, and emergency procedures known and agreed by all staff. Trees should only be climbed by experienced and fully competent persons. Climbers should be equipped with safety equipment with a sufficient breaking strength.

Clearing windblow, snow breakage and forest fires or other catastrophes is one of the most hazardous operations in forestry. All forest personnel who may be called upon for firefighting should receive training.

7. Particular hazards in the Portuguese Forestry

Pine cones gather, Pine Processionary Moth exposure, eucalyptus logging, bark harvest from cork trees and the limited use of PPE are some of particular hazards in the Portuguese forestry operations.

7.1 Hazards associated to pine cones

Pines cones may be gathered by hand or by using a vibratory tool. Manual operations are used in 20-70% of the pines cones harvested in south Europe [1]. When pines cones are gathered by hand, a special portable extensive escalator and a long wood stick in order to remove the cones from the tops and branches are used. Falling from trees and from portable ladders is the most common cause of accidents during cone gathering (5-15 meters high) [1].

In Portugal, protective helmets provide head protection when pines cones are gathered by using a vibratory tool (a pine cone has an average weight of 300 g and may fall down 15 m high).

The Pine Processionary Moth (*Thaumetopoea pityocampa*) attacks pine and cedar forests in all Mediterranean countries. If the caterpillar hairs are touched, they release an extremely nasty allergic skin reaction. They can cause urticarial dermatitis with intense itching, oedema with or without dermatitis, conjunctivitis and keratitis if there is eye contact, rhinitis, pharyngitis, and bronchitis as a result of penetration of the respiratory tract.

7.2 Hazards associated to eucalyptus logging

Mechanical logging operations may be easily applied to eucalyptus trees with a single trunk; however, after cutting the first trunk 2/3 new branches start growing low on the trunk, making difficult to use an harvester to process the tree in the next cutting period. Manual cutting operations with a chainsaw are needed. Eucalyptus represents a high-risk tree for chainsaw accidents in Portugal [1].

7.3 Hazards associated to cork trees harvest

The bark is manually harvested from a cork tree with a special axe during the period May-August.

However the highest risk to accidents occurs during limbing the trees in the period November-March, by using a special limbing chainsaw, operated by a single hand. The operation is performed standing on a portable ladder or on the tree (trees are humid and have slippery moss during this season). Ninety percent of the accidents in cork tree harvesting occur during limbing operations and 10% during bark harvesting. Injuries and open wounds (lacerations, open wounds, cuts, and contusions with wounds) and falls from cork trees (2-3 meters high) are the most frequent injuries and cause of accidents during these operations [1].

7.4 The use of PPE

The cost of the equipment, the extra weight on the worker, the interference with worker mobility and the heat stress caused by the equipment (particularly during summer works in Portugal) are some of the reasons referred to by the workers to limit its use in forestry Portuguese operations.

8. Preventive measures in forestry work

8.1 Introduction

Accident prevention may be restricted to issuing safety regulations at government or company level and distributing first aid boxes and some personal protective equipment like safety helmets, which may or may not be used. Under such conditions, the safety situation in forestry can be expected to remain alarming. This has been more or less the situation in most industrialized countries [21].

Safety and Health Codes of Practice aim to protect workers from hazards in forestry work and to prevent or reduce the incidence of occupational illness or injury by providing practical guidelines. The ILO code of practice for safety and health in forestry work was approved in 1997 [20]; the New Zealand Code of Practice for Safety and Health in Forest Operations was approved in 1999 [9]; the Australian Code of Practice – (No. 12) – Safety in Forest Operations was first published in 1990; the Code of Practice 2002, Safety in Forest Harvesting Operations was published in 2002 [37]; the Forest Safety Code (Tasmania, Australia) was published in 2002 [16]; the Forest Harvesting Code of Practice 2007 (Queensland, Australia) was published in 2007 [36]; the Code of Practice for Managing Safety and Health in Forestry Operations (Ireland) was published by the Health and Safety Authority in 2003 [17].

A meeting of experts drew up the ILO code of practice from major timber-producing countries (with governments, employer's and workers representatives), in Geneva in 1997. According to this Code of Practice, satisfactory safety and health levels are achieved when a number of closely related principles have been applied at national, enterprise and worksite levels. These principles include compliance with laws and regulations, and a clearly defined policy, which identifies the nature and severity of the risks, associated with forestry operations as well as the allocation of responsibility to those persons employed at the levels of management, supervision and execution [20].

8.2 Preventive measures at National level

Preventive measures at National level include [20]:

- Legal framework and duties of competent authorities: the competent authorities should devise and maintain a national policy concerning forestry works.
- Labour inspection: labour inspectorates should monitor compliance with and enforce all relevant laws and regulations at the workplace.
- OSH policy for the forestry industry: the competent authorities should adopt laws or regulations to ensure the safety and health of workers employed in forestry activities.
- Worker's compensation: laws and regulations should provide coverage through workers' compensation in the event of occupational accidents and diseases, and compensation for survivors in the event of work-related death.
- Practical guidance at national level.
- Forestry training institutions.
- Duties of manufacturers and suppliers of equipment and substances.

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- Rights and responsibilities of contractors, managers, supervisors and employees.

8.3 Preventive measures at Enterprise level

The Council Directive 89/391/EEC of 12 June 1989 imposes a general duty on employers to ensure the health and safety at work of all employees. Directives are transposed into national legislation by the Member State, which may also have their own specific legislation. Key aspects must be emphasized to forestry companies, some of them already included in the directive 89/391/EEC:

- Enterprise safety and health policy: The management of an enterprise involved in forestry work should be aware of its responsibility for and actively promote safety and health.
- Safety and health management: This includes Assignment of responsibility (Managers, supervisors and operatives), the identification and management of risks (for each task and activity a risk evaluation should be carried out), organization of personnel (concerning safety and health representatives), provision of resources (to ensure the effective implementation and maintenance of safety and health measures), communication and information (concerning safety practices to workers, contractors and selfemployed persons) and documentation.
- Employment conditions: this includes working hours, shift work and night work.
- Qualifications of managers, supervisors and operatives: Qualifications of managers and supervisors as well training and skills testing for operatives.
- Qualifications of contractors.
- Safety requirements for tools, machines and hazardous chemicals.
- Work clothing and personal protective equipment: Each employer should evaluate the need for personal protective equipment in the prevailing conditions and working clothes should be manufactured from materials, which keep the workers' body dry, and at a comfortable temperature.
- Testing and certification of equipment.
- First aid, emergency rescue and occupational health services: Since it is common that forestry workers work in small groups at separate locations, every worker should be trained in basic first aid. Transport or a means of communication should be available at the worksite to contact rescue services in case of an emergency.

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- Occupational health services and medical care: professionals who are qualified to deal with problems specific to forestry work should provide occupational health services.
 - Shelters, housing and nutrition: Shelters should be made available for protection from inclement weather and for spending breaks, taking meals and drying and storing clothing, at or within easy access of the worksite.

8.4 Preventive measures at Worksite level

A wide variety of working methods are used in forestry operations and the work consists of a multitude of different tasks. A large variety of technical guidelines for safety and health at the forestry worksite are referred to in the literature. Key preventive aspects at worksite level will be summarized in this article.

- Site inspection, planning and organization of forestry work: All forestry activities should be thoroughly planned and organized in advance to prevent inefficiency and to ensure proper levels and control of safe practice and work progress. It is essential to evaluate environmental factors that have an impact on safety as part of the planning process.
- Work organization: The tasks and responsibilities of workers and supervisors should be clearly defined.
- Protection from unfavourable weather conditions and biological hazards: Forestry operations are commonly undertaken in conditions exposing workers to unfavourable weather and biological hazards.
- Felling and conversion: When planning the felling direction, the method of extraction and the route are important factors, because safety and productivity are highly dependent on how logs are positioned relative to the direction of extraction. Safety procedures and preventive measures may include manual and chain saw felling, taking down cut-up or hung-up trees, manual and chain saw debranching, manual and chain-saw crosscutting and mechanized felling and conversion (harvesting machines).
- Logs extraction: Extraction routes suitable for the extraction method and direction should be planned prior to the operation and clearly marked in the working area; generally, logs should be prepared prior to extraction operations by cutting them into the designated specification, to control the weight of the load and minimize damage to remaining trees; specific local conditions require different extraction methods (manual extraction, extraction by chute, extraction with draught animals, extraction by skidder and winch, extraction by forwarder and extraction by cable crane).

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- Landing and stacking: Piling and loading should be mechanized as far as practicable, to avoid heavy physical strain and the risk of accidents associated with manual handling.
 - Loading and transport of timber: Manual loading of transports should be avoided.

9. Conclusions

Accident prevention cannot just be left to the worker – he is only the last link in the chain of events and complex circumstances leading to his injury [21]. The Scandinavian countries, notably Sweden and Finland, have been pacemakers by systematically exploring and applying a wide spectrum of safety measures and making safety considerations an integral feature of all operational activities from planning to organization to execution and supervision of work. This requires active involvement of management and workers, employers' organizations, workers' organizations, accident insurance agencies, manufacturers of forestry machines and equipment, forestry training institutions, research institutions and government authorities.

Further on-line information

- The National Timber Harvesting and Transportation Safety Foundation, sponsored on-line resources that can help reduce forest workers' exposure to accidents, injuries, and fatalities. (<http://www.loggingsafety.com/index.html>)
- The following eTool was developed by OSHA and outlines the required and recommended work practices that can reduce logging hazards. (<http://www.osha.gov/SLTC/etools/logging/mainpage.html>)
- The Health and Safety Executive provides free leaflets to the Forestry sector. (<http://www.hse.gov.uk/pubns/forindex.htm>)

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